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January 5, 2015

Sherrel Henry
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US Environmental Protection Agency, Region 2
290 Broadway, 20th Floor
New York, NY 10007-1866

Re: Shieldalloy Metallurgical Corporation Superfund Site
Newfield, NJ
In the Matter of CERCLA Docket No. 02-2010-2017
OU1 Risk Calculation Update

Dear Ms. Henry:

TRC Environmental, Inc. (TRC) provides this update to Operable Unit 1 (OU1) risk calculations for the Shieldalloy Metallurgical Corp. (SMC) Superfund Site in response to a request by the Environmental Protection Agency (EPA) in correspondence dated November 14, 2014. More specifically, in comment #11, EPA requested that TRC update the risk calculations for hexavalent chromium, beryllium, and other metals that EPA has revised toxicity criteria since the project's 1995 Risk Assessment. The purpose of the update is to provide a comparison of the current risk profile for affected metals to the 1995 Risk Assessment. The methodology used, and the results and conclusions determined are discussed in the subsections below.

Methodology

In order to update the OU1 risk calculations, TRC first identified which site metals EPA has revised toxicity criteria since the 1995 risk assessment. Toxicity values were obtained based upon OSWER Directive 9285.7-53 hierarchy. The following constituents and EPA changes were noted:

Constituent	Change in EPA Risk Approach Since 1995
Beryllium	No longer considered a carcinogen, revised reference dose
Boron	Revised reference dose
Chromium (as trivalent)	Revised reference dose
Chromium (hexavalent)	Considered a carcinogen, revised reference dose
Vanadium	Revised reference dose

The 1995 Risk Assessment calculated risk for both the shallow and deep aquifers from off-site wells. This 2014 OU1 risk update also calculated risk for both the off-site shallow and deep aquifers. The 1995 Risk Assessment used groundwater data for a limited number of wells, available at that time. The current network of wells is much more robust than those available in 1995. TRC used the robust current network of wells as the basis of groundwater data for the 2014 analysis. TRC calculated the 95% Upper Confidence Limit (UCL) for chromium (as trivalent) and chromium (hexavalent), as the exposure point concentration (EPC), based on October 2014 sampling event results. Chromium is the primary constituent of concern for OU1, and has been the focus of significant remediation (successfully lowering aquifer concentrations), so this robust data analysis was appropriate for this compound. TRC used the maximum detections for vanadium, based on recent sampling, as a conservative approach (the vanadium data set did not meet the requirements for the 95% UCL analysis). TRC used the 1995 concentrations for boron and beryllium, as a conservative approach.

The 2014 OU1 risk update evaluated both an adult and child exposure scenario and is consistent with current risk assessment guidance and the current recommended exposure parameters (OSWER Directive 9200.120, February 2014). It should be noted that the 1995 Risk Assessment only evaluated a 30-year Adult resident (not the child resident). It is also noted that a well restriction area exists over much of the area, and that EPA is pursuing additional institutional controls, so actual exposure is extremely unlikely, however risk calculations were conservatively calculated for an off-site resident exposed to ground water.

Consistent with the 1995 Risk Assessment, TRC calculated either cancer and/or non-cancer risks (hazard quotient, HQ) for the target constituents.

Findings

Findings are summarized in Tables 1 and 2 which provide the comparison of the 1995 Risk versus the 2014 Risk for the shallow and deep aquifer's ,respectively. The back-up tables to support these summary tables can be found in Appendix A. Of the five target compounds, only chromium (hexavalent) is currently considered a carcinogen, yielding a cancer risk of 4E-04 and 6E-03 for the shallow and deep aquifers, respectively.

The comparative HQs for the shallow aquifer are:

Constituent	1995 HQ	2014 HQ	Notes
Beryllium	3.1	23	Increased due to change in RfD/methodology
Boron	4.4	3.8	Slight decrease due to change in RfD/methodology
Chromium (as trivalent)	0.002	0.01	Increased due to apparent increase in EPC
Chromium (hexavalent)	0.044	1.3	Increased due to apparent increase in EPC
Vanadium	508	28	Decreased due to decrease in EPC

The comparative HQs for the deep aquifer are:

Constituent	1995 HQ	2014 HQ	Notes
Beryllium	0.062	0.45	Increased due to change in RfD/methodology
Boron	0.047	0.04	Slight decrease due to change in RfD/methodology
Chromium (as trivalent)	2.4	0.05	Decreased due to decrease in EPC
Chromium (hexavalent)	7,671	22	Decreased due to decrease in EPC
Vanadium	7.9	2.9	Decreased due to decrease in EPC

The most conservative cancer risk estimates and HQs are presented and are based upon the adult resident receptor for cancer risk and the child resident receptor for non-cancer effects.

Conclusions

OU1 risk calculations were updated to reflect current risk assessment methodology for those site constituents for which toxicity criteria have changed, providing a framework to understand current risk.

Shallow Aquifer

Updated risk calculations for the shallow aquifer indicate that the HQs for boron and vanadium have decreased since the 1995 risk analysis. Based upon the change in RfD and updated risk calculations, the 2014 HQ for beryllium increased by ~7 fold. This is primarily due to current EPA methodology to evaluate a child receptor and evaluate dermal exposure to metals in ground water (the 1995 risk assessment did not calculate dermal risk). The 2014 HQs for chromium and hexavalent chromium are slightly higher than 1995 risk which is due to an apparent increase in the ground water concentration. This apparent increase adds some uncertainty, because of the limited number of wells available in 1995, versus the robust network of wells currently available. Other analyses, provided as part of the OU1 In Situ Program, have demonstrated that the shallow (and deep) chromium plumes have actually been decreased, both in footprint and concentrations, between 1995 and 2014. This risk calculation update refers to the results using 1995 data (with its inherent uncertainty) to make a consistent comparison to the former calculations.

The cancer risk for chromium (hexavalent) was calculated to be 4E-04, based on EPA's current considerations of this potential carcinogen.

Deep Aquifer

Updated risk calculations for the deep aquifer indicate that the HQs for boron, chromium (as trivalent), chromium (hexavalent) and vanadium have decreased since the 1995 risk analysis. Based upon the change in RfD and updated risk calculations, the 2014 HQ for beryllium increased by ~7 fold. This is primarily due to current EPA methodology to evaluate a child receptor and evaluate dermal exposure to metals in ground water (the 1995 risk assessment did not calculate dermal risk).

The cancer risk for chromium (hexavalent) was calculated to be 6E-03, based on EPA's current considerations of this potential carcinogen.

It is noted that the deep aquifer 95% UCL concentration of chromium (as trivalent) has decreased from 88 mg/l in 1995 to 1.081 mg/l in 2014, and that the chromium (hexavalent) 95% UCL concentration has decreased significantly from 1,400 mg/l in 1995 to 0.98 mg/l in 2014. These positive results are a reflection of the success of in situ remediation activities. Additionally, a well restriction area exists over much of the area, and EPA is pursuing additional institutional controls, so, although the cancer risk exceeds EPA's risk level of 1E-04, actual exposure is extremely unlikely.

Please let us know if you require additional information.

Regards,
TRC

Patrick J. Hansen
Project Coordinator

Cc: David White, SMC
Donna Gaffigan, NJDEP
Dr. Karen Vetrano, TRC

TABLES

Table 1
Comparison of 1995 Risk Assessment Results versus 2014 Risk Assessment (Methodologies and Toxicity Criteria)
Shieldalloy Metallurgical Corporation - OU1 - Off-Site Groundwater - Shallow
Newfield, New Jersey

	1995					2014						
Constituent	**GW Concentration used in 1995 RA (mg/l) (statistic)**	**Cancer Slope Factor**	**Cancer Risk**	**RfD**	**HQ**	**GW Concentration used in 2014 RA (mg/l) (statistic)**	**Cancer Slope Factor**	**Cancer Risk (a)**	**RfD**	**HQ (b)**	**Note**	**Source of Toxicity Criteria (c)**
Beryllium	0.57 (max)	4.3E+00	3E-02	5.0E-03	3.1	0.57 (max)	NA	NC	2.0E-03	**23**	Used 1995 groundwater concentration as a conservatie approach. CSF withdrawn. 2014 RfD is 2.5x lower than 1995 RfD, HQ increased.	RfD - Tier I value (USEPA IRIS)
Boron	15 (max)	NA	--	9.0E-02	4.4	15 (max)	NA	NC	2.0E-01	*3.8*	Used 1995 groundwater data as a conservative approach. 2014 RfD is 2.2x higher than 1995 RfD, HQ decreased	RfD - Tier I value (USEPA IRIS)
Chromium (as Cr III)	0.077 (95% UCL)	NA	NC	1.0E+00	0.002	0.249 (95% UCL)	NA	NC	1.5E+00	**0.01**	2014 EPC increased by 2.3x. RfD increased by 1.5x, HQ increased.	RfD - Tier I value (USEPA IRIS)
Chromium VI	0.008 (max)	NA	NC	5.0E-03	0.044	0.056 (95% UCL)	5E-01	**4E-04**	3.0E-03	**1.3**	2014 EPC increased by 7x. Currently considered a carcinogen, if 1995 GW concentration analyzed with 2014 CSF, cancer risk = 8.8. RfD decreased by 1.67x, HQ increased.	CSF - Tier III value - NJ DEP (2014 USEPA RSL Table) RfD - Tier I value (USEPA IRIS)
Vanadium	130 (max)	NA	--	7.0E-03	508	2.40 (max)	NA	NC	5.0E-03	*28*	Most vanadium concentrations are non detect. The 2014 EPC represents maximum of 2 detects. 2014 RfD is 1.4x lower than 1995 RfD, HQ decreased	RfD - Tier I value (USEPA IRIS), derived from the IRIS oral RfD for Vanadium Pentoxide by factoring out the molecular weight (MW) of the oxide ion. Vanadium Pentoxide (V205) has a molecular weight of 181.88. The two atoms of Vanadium contribute 56% of the MW. Vanadium Pentoxide's oral RfD of 9E-03 mg/kg-day multiplied by 56% gives a Vanadium oral RfD of 5.04E-03 mg/kg-day (RSL User's Guide).
			3E-02		516			*4E-04*		*56*		

Bold = increase from 1995
Italics and highlighted = Decrease from 1995

2014 evaluatior October 2014 GW data used when available; also used current risk assessment methodologies and most recent (2014) OSWER recommended exposure parameters
NA = Not available
NC = this parameter is not a carcinogen, so it is not appropriate to calculate
RfD = reference dose
HQ = Hazard quotient
(a) Based on adult exposure, 1995 RA evaluated 30 yr Adult Resident exposure
(b) Based on child exposure, 1995 RA evaluated 30 yr Adult Resident exposure
(c) Toxicity value hierarchy based upon OSWER Directive 9285.7-53.

Table 2
Comparison of 1995 Risk Assessment Results versus 2014 Risk Assessment (Methodologies and Toxicity Criteria)
Shieldalloy Metallurgical Corporation - OU1 - Off-Site Groundwater - Deep
Newfield, New Jersey

	1995					2014						
Constituent	**GW Concentration used in 1995 RA (mg/l) (statistic)**	**Cancer Slope Factor**	**Cancer Risk**	**RfD**	**HQ**	**GW Concentration used for 2014 (mg/l) (statistic)**	**Cancer Slope Factor**	**Cancer Risk (a)**	**RfD**	**HQ (b)**	**Note**	**Source of Toxicity Criteria (c)**
Beryllium	0.011 (max)	4.3E+00	6E-04	5.0E-03	0.062	0.011 (max)	NA	NC	2.0E-03	**0.45**	Used 1995 groundwater concentrations as a conservative approach. CSF withdrawn. 2014 RfD is 2.5x lower than 1995 RfD, HQ increased.	RfD - Tier I value (USEPA IRIS)
Boron	0.16 (max)	NA	--	9.0E-02	0.047	0.16 (max)	NA	NC	2.0E-01	*0.04*	No recent data, used 1995 EPC. 2014 RfD is 2.2x higher than 1995 RfD, HQ decreased	RfD - Tier I value (USEPA IRIS)
Chromium (as Cr III)	88 (95% UCL)	NA	NC	1.0E+00	2.4	1.081 (95% UCL)	NA	NC	1.5E+00	*0.05*	2014 EPC decreased by ~80x. RfD increased by 1.5x, HQ decreased.	RfD - Tier I value (USEPA IRIS)
Chromium VI	1400 (max)	NA	NC	5.0E-03	7,671	0.98 (95% UCL)	5E-01	**6E-03**	3.0E-03	*22*	2014 EPC decreased by ~1,430x. Currently considered a carcinogen, if 1995 GW concentration analyzed with 2014 CSF, cancer risk = 8.8. RfD decreased by 1.67x, HQ decreased.	CSF - Tier III value - NJ DEP (2014 USEPA RSL Table) RfD - Tier I value (USEPA IRIS)
Vanadium	2 (max)	NA	--	7.0E-03	7.9	0.25 (max)	NA	NC	5.0E-03	*2.9*	Most groundwater concentrations are non detect. The concentrations used for the calculation represents single detect. 2014 RfD is 1.4x lower than 1995 RfD, HQ decreased.	RfD - Tier I value (USEPA IRIS), derived from the IRIS oral RfD for Vanadium Pentoxide by factoring out the molecular weight (MW) of the oxide ion. Vanadium Pentoxide (V205) has a molecular weight of 181.88. The two atoms of Vanadium contribute 56% of the MW. Vanadium Pentoxide's oral RfD of 9E-03 mg/kg-day multiplied by 56% gives a Vanadium oral RfD of 5.04E-03 mg/kg-day (RSL User's Guide).
Total		6E-04			7681			**6E-03**		*25*		

Bold = increase from 1995
Italics and highlighted = Decrease from 1995

2014 evaluatior October 2014 GW data used when available; also used current risk assessment methodologies and most recent (2014) OSWER recommended exposure parameters
NA = Not available
NC = this parameter is not a carcinogen, so it is not appropriate to calculate
RfD = reference dose
HQ = Hazard quotient
(a) Based on adult exposure, 1995 RA evaluated 30 yr Adult Resident exposure
(b) Based on child exposure, 1995 RA evaluated 30 yr Adult Resident exposure
(c) Toxicity value hierarchy based upon OSWER Directive 9285.7-53.

APPENDIX A

CANCER AND NON-CANCER RISK SUPPORT TABLES

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TABLE 3.1
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Sheildalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Scenario Timeframe:	Future
Medium:	Ground Water
Exposure Medium:	Off-Site Groundwater - Shallow Aquifer

Exposure Point	CAS #	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration	Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Tap Water	7440-41-7	Beryllium	ug/L	NC	NC		570	570	ug/L	Maximum	No new data, 1995 EPC
	7440-42-8	Boron	ug/L	NC	NC		15000	15000	ug/L	Maximum	No new data, 1995 EPC
	7440-47-3	Chromium	ug/L	160.6	249	N	830	249	ug/L	Student's t-UCL	ProUCL (See Appendix B)
	18540-29-9	Chromium VI	ug/L	74.5	56	G	270	56	ug/L	95% Adjusted Gamma KM-UCL	ProUCL (See Appendix B)
	1314-62-1	Vanadium	ug/L	NC	NC		2400	2400	ug/L	Maximum	Insufficient N to calculate UCL

NC - Not Calculated
N - Normal Distribution
G - Gamma Distribution

TABLE 3.2
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Sheildalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Off-Site Ground Water - Deep Aquifer

Exposure Point	CAS #	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration	Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Tap Water	7440-41-7	Beryllium	ug/L	NC	NC		11	11	ug/L	Maximum	No new data, 1995 EPC
	7440-42-8	Boron	ug/L	NC	NC		160	160	ug/L	Maximum	No new data, 1995 EPC
	7440-47-3	Chromium	ug/L	662.8	1081	G	5410	1081	ug/L	95% Adjusted Gamma UCL	ProUCL (See Appendix B)
	18540-29-9	Chromium VI	ug/L	939	977	G	4300	977	ug/L	95% Adjusted Gamma KM-UCL	ProUCL (See Appendix B)
	1314-62-1	Vanadium	ug/L	NC	NC		248	248	ug/L	Maximum	Insufficient N to calculate UCL

NC - Not Calculated
G - Gamma Distribution

Table 4.1 RME
Values Used For Daily Intake Calculations
Shieldalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Scenario Timeframe:	Future
Medium:	Ground Water
Exposure Medium:	Tapwater

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Resident	Ingestion	Adult	Ground Water Off-Site	EPC	Water Exposure Point Concentration	Chemical Specific	mg/L	See Table 3.1 RME	Intake = EPC x IR x EF x ED/(BW x AT)
				IR	Water Ingestion Rate	2.5	L/day	USEPA 1989	
				EF	Exposure Frequency	350	days/year	USEPA 2014	
				ED	Exposure Duration	20	years	USEPA 2014	
				BW	Body Weight	80	kg	USEPA 2014	
				ATc	Averaging Time - cancer	25550	days	USEPA 1989	
				ATnc	Averaging Time - non-cancer	7300	days	ED x 365, USEPA 1989	
	Dermal	Adult	Ground Water Off-Site	DAevent	Absorbed Dose per Event	Table 4-1 Supplemental	mg/cm2-event	USEPA 2004	Dermal Absorbed Dose (DAD) = (Daevent x EV x EF x ED x SA)/(BW x AT) (USEPA 2004)
				EPC	Water Exposure Point Concentration	Chemical Specific	mg/kg	See Table 3.1 RME	
				ABSd	Dermal Absorption Fraction	Chemical Specific	unitless	USEPA 2004	where:
				tevent	Event Duration	0.71	hour/event	USEPA 2014	DAevent = calculated per USEPA 2004
				EV	Event Frequency	1	event/day	BPJ	
				EF	Exposure Frequency	350	days/year	USEPA 2014	
				ED	Exposure Duration	20	years	USEPA 2014	
				SA	Skin Surface Area available for contact	20900	cm2	total body while showering, USEPA 2014	
				BW	Body Weight	80	kg	USEPA 2014	
				ATc	Averaging Time - cancer	25550	days	USEPA1989	
				ATnc	Averaging Time - non-cancer	7300	days	ED x 365, USEPA 1989	
	Ingestion	Child	Ground Water Off-Site	EPC	Water Exposure Point Concentration	Chemical Specific	mg/L	See Table 3.1 RME	
				IR	Water Ingestion Rate	0.78	L/day	USEPA 2014	
				EF	Exposure Frequency	350	days/year	USEPA 2014	
				ED	Exposure Duration	6	years	USEPA 2014	
				BW	Body Weight	15	kg	USEPA 2014	
				ATc	Averaging Time - cancer	25550	days	USEPA 1989	
				ATnc	Averaging Time - non-cancer	2190	days	ED x 365, USEPA 1989	
	Dermal	Child	Ground Water Off-Site	DAevent	Absorbed Dose per Event	Table 4-1 Supplemental	mg/cm2-event	USEPA 2004	Dermal Absorbed Dose (DAD) = (Daevent x EV x EF x ED x SA)/(BW x AT) (USEPA 2004)
				EPC	Water Exposure Point Concentration	Chemical Specific	mg/L	See Table 3.1 RME	
				ABSd	Dermal Absorption Fraction	Chemical Specific	unitless	USEPA 2004	where:
				tevent	Event Duration	0.54	hour/event	USEPA 2014	DAevent = calculated per USEPA 2004
				EV	Event Frequency	1	event/day	BPJ	
				EF	Exposure Frequency	350	days/year	USEPA 2014	
				ED	Exposure Duration	6	years	USEPA 2014	
				SA	Skin Surface Area available for contact	6378	cm2	total body while bathing, USEPA 2014	
				BW	Body Weight	15	kg	USEPA 2014	
				ATc	Averaging Time - cancer	25550	days	USEPA1989	
				ATnc	Averaging Time - non-cancer	2190	days	ED x 365, USEPA 1989	

Table 4-1 Supplemental
DA_{event} Model
Dermal Exposure while Showering/Bathing - Off-Site Ground Water
Sheildalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Constituent	Absorbed Dose Per Event (mg/cm^2-event) Adult Deep	Absorbed Dose Per Event (mg/cm^2-event) Child Deep	Absorbed Dose Per Event (mg/cm^2-event) Adult Shallow	Absorbed Dose Per Event (mg/cm^2-event) Child Shallow	Kp Dermal Permeability Coefficient (cm/hr)	Cw Chemical Concentration in Water (mg/cm^3) Deep	Cw Chemical Concentration in Water (mg/cm^3) Shallow
Metals, total							
Beryllium	7.8E-09	5.9E-09	4.0E-07	3.1E-07	1.0E-03	1.10E-05	5.70E-04
Boron	1.1E-07	8.6E-08	1.1E-05	8.1E-06	1.0E-03	1.60E-04	1.50E-02
Chromium	7.7E-07	5.8E-07	1.8E-07	1.3E-07	1.0E-03	1.08E-03	2.49E-04
Chromium VI	1.4E-06	1.1E-06	8.0E-08	6.0E-08	2.0E-03	9.77E-04	5.60E-05
Vanadium (Total)	1.8E-07	1.4E-07	1.7E-06	1.3E-06	1.0E-03	2.50E-04	2.40E-03

Inorganics:
Daevent = Kp x Cw x tevent

tevent - Adult	0.71	hours
Child	0.54	hours

TABLE 7.1a.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Sheildalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSFo		Cancer Risk	Intake/Exposure Concentration		RfD		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Ground Water	Ground Water Shallow Aquifer	Tapwater	Ingestion	Beryllium	5.7E-01	mg/L	4.9E-03	mg/kg-day	NA		NA	1.7E-02	mg/kg-day	2.0E-03	mg/kg-d	**8.5E+00**
				Boron	1.5E+01	mg/L	1.3E-01	mg/kg-day	NA		NA	4.5E-01	mg/kg-day	2.0E-01	mg/kg-d	**2.2E+00**
				Chromium	2.5E-01	mg/L	2.1E-03	mg/kg-day	NA		NA	7.5E-03	mg/kg-day	1.5E+00	mg/kg-d	5.0E-03
				Chromium VI	5.6E-02	mg/L	4.8E-04	mg/kg-day	5.0E-01	(mg/kg-d)-1	***2E-04***	1.7E-03	mg/kg-day	3.0E-03	mg/kg-d	5.6E-01
				Vanadium	2.4E+00	mg/L	2.1E-02	mg/kg-day	NA		NA	7.2E-02	mg/kg-day	5.0E-03	mg/kg-d	**1.4E+01**
			Exp. Route Total								***2.E-04***					**2.6.E+01**
			Dermal Contact	Beryllium	5.7E-01	mg/L	2.9E-05	mg/kg-day	NA		NA	1.0E-04	mg/kg-day	1.4E-05	mg/kg-d	**7.2E+00**
				Boron	1.5E+01	mg/L	7.6E-04	mg/kg-day	NA		NA	2.7E-03	mg/kg-day	2.0E-01	mg/kg-d	1.3E-02
				Chromium	2.5E-01	mg/L	1.3E-05	mg/kg-day	NA		NA	4.4E-05	mg/kg-day	2.0E-02	mg/kg-d	2.3E-03
				Chromium VI	5.6E-02	mg/L	5.7E-06	mg/kg-day	2.0E+01	(mg/kg-d)-1	***1E-04***	2.0E-05	mg/kg-day	7.5E-05	mg/kg-d	2.7E-01
				Vanadium	2.4E+00	mg/L	1.2E-04	mg/kg-day	NA		NA	4.3E-04	mg/kg-day	1.3E-04	mg/kg-d	**3.3E+00**
			Exp. Route Total								**1E-04**					**1.1E+01**
		Exposure Point Total									***4E-04***					**3.7E+01**
	Exposure Medium Total										***4E-04***					**3.7E+01**
Medium Total											***4E-04***					**3.7E+01**
											Total of Receptor Risks Across All Media					Total of Receptor Hazards Across All Media

Bold = Cancer Risk >1E-06 or HI >1E+00
Italic = Cancer Risk > 1E-04

TABLE 9.1a.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Sheildalloy Metallurgical Corporation - OU1

Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Off-Site Ground Water Shallow Aquifer	Tap Water	Beryllium	NA		NA		NA		**8.5E+00**		**7.2E+00**	**1.6E+01**
			Boron	NA		NA		NA		**2.2E+00**		1.3E-02	**2.3E+00**
			Chromium	NA		NA		NA		5.0E-03		2.3E-03	7.2E-03
			Chromium VI	***2E-04***		***1E-04***		***4E-04***		5.6E-01		2.7E-01	8.2E-01
			Vanadium	NA		NA		NA		**1.4E+01**		**3.3E+00**	**1.8E+01**
			Chemical Total					***4E-04***					**3.7E+01**
		Exposure Point Total						***4E-04***					**3.7E+01**
	Exposure Medium Total							***4E-04***					**3.7E+01**
Medium Total								***4E-04***					**3.7E+01**
Receptor Total							Receptor Risk Total	***4E-04***				Receptor HI Total	**3.7E+01**

Bold = Cancer Risk >1E-06 or HI >1E+00

Italic = Cancer Risk > 1E-04

TABLE 7.1b.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Sheildalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSFo		Cancer Risk	Intake/Exposure Concentration		RfD		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Ground Water	Ground Water Shallow Aquifer	Tapwater	Ingestion	Beryllium	5.7E-01	mg/L	2.4E-03	mg/kg-day	NA		NA	2.8E-02	mg/kg-day	2.0E-03	mg/kg-d	**1.4E+01**
				Boron	1.5E+01	mg/L	6.4E-02	mg/kg-day	NA		NA	7.5E-01	mg/kg-day	2.0E-01	mg/kg-d	**3.7E+00**
				Chromium	2.5E-01	mg/L	1.1E-03	mg/kg-day	NA		NA	1.2E-02	mg/kg-day	1.5E+00	mg/kg-d	8.3E-03
				Chromium VI	5.6E-02	mg/L	2.4E-04	mg/kg-day	5.0E-01	(mg/kg-d)-1	**1E-04**	2.8E-03	mg/kg-day	3.0E-03	mg/kg-d	9.3E-01
				Vanadium	2.4E+00	mg/L	1.0E-02	mg/kg-day	NA		NA	1.2E-01	mg/kg-day	5.0E-03	mg/kg-d	**2.4E+01**
			Exp. Route Total								**1.E-04**					**4.3.E+01**
			Dermal Contact	Beryllium	5.7E-01	mg/L	1.1E-05	mg/kg-day	NA		NA	1.3E-04	mg/kg-day	1.4E-05	mg/kg-d	**9.0E+00**
				Boron	1.5E+01	mg/L	2.8E-04	mg/kg-day	NA		NA	3.3E-03	mg/kg-day	2.0E-01	mg/kg-d	1.7E-02
				Chromium	2.5E-01	mg/L	4.7E-06	mg/kg-day	NA		NA	5.5E-05	mg/kg-day	2.0E-02	mg/kg-d	2.8E-03
				Chromium VI	5.6E-02	mg/L	2.1E-06	mg/kg-day	2.0E+01	(mg/kg-d)-1	**4E-05**	2.5E-05	mg/kg-day	7.5E-05	mg/kg-d	3.3E-01
				Vanadium	2.4E+00	mg/L	4.5E-05	mg/kg-day	NA		NA	5.3E-04	mg/kg-day	1.3E-04	mg/kg-d	**4.1E+00**
			Exp. Route Total								**4E-05**					**1.3E+01**
		Exposure Point Total									***2E-04***					**5.6E+01**
	Exposure Medium Total										***2E-04***					**5.6E+01**
Medium Total											***2E-04***					**5.6E+01**
											Total of Receptor Risks Across All Media					Total of Receptor Hazards Across All Media
											2E-04					**5.6E+01**

Bold = Cancer Risk >1E-06 or HI >1E+00
Italic = Cancer Risk > 1E-04

TABLE 9.1b.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Sheildalloy Metallurgical Corporation - OU1

Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Off-Site Ground Water Shallow Aquifer	Tap Water	Beryllium	NA		NA		NA		**1.4E+01**		**9.0E+00**	**2.3E+01**
			Boron	NA		NA		NA		**3.7E+00**		1.7E-02	**3.8E+00**
			Chromium	NA		NA		NA		8.3E-03		2.8E-03	1.1E-02
			Chromium VI	**1E-04**		**4E-05**		***2E-04***		9.3E-01		3.3E-01	**1.3E+00**
			Vanadium	NA		NA		NA		**2.4E+01**		**4.1E+00**	**2.8E+01**
			Chemical Total					***2E-04***					**5.6E+01**
		Exposure Point Total						***2E-04***					**5.6E+01**
	Exposure Medium Total							***2E-04***					**5.6E+01**
Medium Total								***2E-04***					**5.6E+01**
Receptor Total							Receptor Risk Total	***2E-04***				Receptor HI Total	**5.6E+01**

Bold = Cancer Risk >1E-06 or HI >1E+00

Italic = Cancer Risk > 1E-04

TABLE 7.2a.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Sheildalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSFo		Cancer Risk	Intake/Exposure Concentration		RfD		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Ground Water	Ground Water Deep Aquifer	Tapwater	Ingestion	Beryllium	1.1E-02	mg/L	9.4E-05	mg/kg-day	NA		NA	3.3E-04	mg/kg-day	2.0E-03	mg/kg-d	1.6E-01
				Boron	1.6E-01	mg/L	1.4E-03	mg/kg-day	NA		NA	4.8E-03	mg/kg-day	2.0E-01	mg/kg-d	2.4E-02
				Chromium	1.1E+00	mg/L	9.3E-03	mg/kg-day	NA		NA	3.2E-02	mg/kg-day	1.5E+00	mg/kg-d	2.2E-02
				Chromium VI	9.8E-01	mg/L	8.4E-03	mg/kg-day	5.0E-01	(mg/kg-d)-1	***4E-03***	2.9E-02	mg/kg-day	3.0E-03	mg/kg-d	**9.8E+00**
				Vanadium	2.5E-01	mg/L	2.1E-03	mg/kg-day	NA		NA	7.4E-03	mg/kg-day	5.0E-03	mg/kg-d	**1.5E+00**
			Exp. Route Total								***4.E-03***					**1.1.E+01**
			Dermal Contact	Beryllium	1.1E-02	mg/L	5.6E-07	mg/kg-day	NA		NA	2.0E-06	mg/kg-day	1.4E-05	mg/kg-d	1.4E-01
				Boron	1.6E-01	mg/L	8.1E-06	mg/kg-day	NA		NA	2.8E-05	mg/kg-day	2.0E-01	mg/kg-d	1.4E-04
				Chromium	1.1E+00	mg/L	5.5E-05	mg/kg-day	NA		NA	1.9E-04	mg/kg-day	2.0E-02	mg/kg-d	9.9E-03
				Chromium VI	9.8E-01	mg/L	9.9E-05	mg/kg-day	2.0E+01	(mg/kg-d)-1	***2E-03***	3.5E-04	mg/kg-day	7.5E-05	mg/kg-d	**4.6E+00**
				Vanadium	2.5E-01	mg/L	1.3E-05	mg/kg-day	NA		NA	4.4E-05	mg/kg-day	1.3E-04	mg/kg-d	3.4E-01
			Exp. Route Total								**2E-03**					**5.1E+00**
		Exposure Point Total									***6E-03***					**1.7E+01**
	Exposure Medium Total										***6E-03***					**1.7E+01**
Medium Total											***6E-03***					**1.7E+01**
											Total of Receptor Risks Across All Media					Total of Receptor Hazards Across All Media

Bold = Cancer Risk >1E-06 or HI >1E+00
Italic = Cancer Risk > 1E-04

TABLE 9.2a.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Sheildalloy Metallurgical Corporation - OU1

Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Off-Site Ground Water Deep Aquifer	Tap Water	Beryllium	NA		NA		NA		1.6E-01		1.4E-01	3.0E-01
			Boron	NA		NA		NA		2.4E-02		1.4E-04	2.4E-02
			Chromium	NA		NA		NA		2.2E-02		9.9E-03	3.1E-02
			Chromium VI	***4E-03***		***2E-03***		***6E-03***		**9.8E+00**		**4.6E+00**	**1.4E+01**
			Vanadium	NA		NA		NA		**1.5E+00**		3.4E-01	**1.8E+00**
			Chemical Total					***6E-03***					**1.7E+01**
		Exposure Point Total						***6E-03***					**1.7E+01**
	Exposure Medium Total							***6E-03***					**1.7E+01**
Medium Total								***6E-03***					**1.7E+01**
Receptor Total							Receptor Risk Total	***6E-03***				Receptor HI Total	**1.7E+01**

Bold = Cancer Risk >1E-06 or HI >1E+00

Italic = Cancer Risk > 1E-04

TABLE 7.2b.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Sheildalloy Metallurgical Corporation - OU1
Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSFo		Cancer Risk	Intake/Exposure Concentration		RfD		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Ground Water	Ground Water Deep Aquifer	Tapwater	Ingestion	Beryllium	1.1E-02	mg/L	4.7E-05	mg/kg-day	NA		NA	5.5E-04	mg/kg-day	2.0E-03	mg/kg-d	2.7E-01
				Boron	1.6E-01	mg/L	6.8E-04	mg/kg-day	NA		NA	8.0E-03	mg/kg-day	2.0E-01	mg/kg-d	4.0E-02
				Chromium	1.1E+00	mg/L	4.6E-03	mg/kg-day	NA		NA	5.4E-02	mg/kg-day	1.5E+00	mg/kg-d	3.6E-02
				Chromium VI	9.8E-01	mg/L	4.2E-03	mg/kg-day	5.0E-01	(mg/kg-d)-1	**2E-03**	4.9E-02	mg/kg-day	3.0E-03	mg/kg-d	**1.6E+01**
				Vanadium	2.5E-01	mg/L	1.1E-03	mg/kg-day	NA		NA	1.2E-02	mg/kg-day	5.0E-03	mg/kg-d	**2.5E+00**
			Exp. Route Total								***2.E-03***					**1.9.E+01**
			Dermal Contact	Beryllium	1.1E-02	mg/L	2.1E-07	mg/kg-day	NA		NA	2.4E-06	mg/kg-day	1.4E-05	mg/kg-d	1.7E-01
				Boron	1.6E-01	mg/L	3.0E-06	mg/kg-day	NA		NA	3.5E-05	mg/kg-day	2.0E-01	mg/kg-d	1.8E-04
				Chromium	1.1E+00	mg/L	2.0E-05	mg/kg-day	NA		NA	2.4E-04	mg/kg-day	2.0E-02	mg/kg-d	1.2E-02
				Chromium VI	9.8E-01	mg/L	3.7E-05	mg/kg-day	2.0E+01	(mg/kg-d)-1	***7E-04***	4.3E-04	mg/kg-day	7.5E-05	mg/kg-d	**5.7E+00**
				Vanadium	2.5E-01	mg/L	4.7E-06	mg/kg-day	NA		NA	5.5E-05	mg/kg-day	1.3E-04	mg/kg-d	4.2E-01
			Exp. Route Total								**7E-04**					**6.3E+00**
		Exposure Point Total									***3E-03***					**2.5E+01**
	Exposure Medium Total										***3E-03***					**2.5E+01**
Medium Total											***3E-03***					**2.5E+01**
											Total of Receptor Risks Across All Media					Total of Receptor Hazards Across All Media
											3E-03					**2.5E+01**

Bold = Cancer Risk >1E-06 or HI >1E+00
Italic = Cancer Risk > 1E-04

TABLE 9.2b.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Sheildalloy Metallurgical Corporation - OU1

Newfield, New Jersey

Scenario Timeframe:	Future
Receptor Population:	Off-Site Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Off-Site Ground Water Deep Aquifer	Tap Water	Beryllium	NA		NA		NA		2.7E-01		1.7E-01	4.5E-01
			Boron	NA		NA		NA		4.0E-02		1.8E-04	4.0E-02
			Chromium	NA		NA		NA		3.6E-02		1.2E-02	4.8E-02
			Chromium VI	***2E-03***		***7E-04***		***3E-03***		**1.6E+01**		**5.7E+00**	**2.2E+01**
			Vanadium	NA		NA		NA		**2.5E+00**		4.2E-01	**2.9E+00**
			Chemical Total					***3E-03***					**2.5E+01**
		Exposure Point Total						***3E-03***					**2.5E+01**
	Exposure Medium Total							***3E-03***					**2.5E+01**
Medium Total								***3E-03***					**2.5E+01**
Receptor Total							Receptor Risk Total	***3E-03***				Receptor HI Total	**2.5E+01**

Bold = Cancer Risk >1E-06 or HI >1E+00

Italic = Cancer Risk > 1E-04

APPENDIX B

ProUCL OUTPUT

Appendix B-1 Shallow Aquifer

Normal UCL Statistics for Data Sets with Non-Detects

Date/Time of Computation	12/31/2014 2:36:07 PM
From File	SMC October 2014_10 Semi-Annual GW Sampling Results_Shallow Off-Site_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Chromium

General Statistics

Total Number of Observations	16	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	1.7	Mean	160.6
Maximum	830	Median	98.35
SD	202.4	SD of logged Data	1.74
Coefficient of Variation	1.26	Skewness	2.63

Normal GOF Test

Shapiro Wilk Test Statistic	0.704	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.216	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.222	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	249.3	95% Adjusted-CLT UCL (Chen-1995)	279.4
		95% Modified-t UCL (Johnson-1978)	254.9

Suggested UCL to Use

95% Student's-t UCL 249.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Chromium, Hexavalent

General Statistics

Total Number of Observations	16	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	12
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	0.0048	Minimum Non-Detect	0.01
Maximum Detect	0.27	Maximum Non-Detect	0.01
Variance Detects	0.017	Percent Non-Detects	75%
Mean Detects	0.0745	SD Detects	0.13
Median Detects	0.0116	CV Detects	1.75
Skewness Detects	1.995	Kurtosis Detects	3.983
Mean of Logged Detects	-3.901	SD of Logged Detects	1.783

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.657	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.429	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0239	Standard Error of Mean	0.0184
SD	0.0636	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0562	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0542	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0791	95% KM Chebyshev UCL	0.104
97.5% KM Chebyshev UCL	0.139	99% KM Chebyshev UCL	0.207

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0224	Mean in Log Scale	-4.949
SD in Original Scale	0.0661	SD in Log Scale	1.013
95% t UCL (Assumes normality)	0.0513	95% H-Stat UCL	0.0242

DL/2 is not a recommended method, provided for comparisons and historical reasons

Suggested UCL to Use

95% KM (t) UCL	0.0562	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix B-2 Deep Aquifer

Normal UCL Statistics for Data Sets with Non-Detects

Date/Time of Computation	12/31/2014 2:32:29 PM
From File	SMC October 2014_10 Semi-Annual GW Sampling Results_Deep off Site_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Chromium

General Statistics

Total Number of Observations	33	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	3.5	Mean	662.8
Maximum	5410	Median	278
SD	1094	Std. Error of Mean	190.5
Coefficient of Variation	1.651	Skewness	3.103

Normal GOF Test

Shapiro Wilk Test Statistic	0.61	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.931	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.282	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.154	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	985.5	95% Adjusted-CLT UCL (Chen-1995)	1086
		95% Modified-t UCL (Johnson-1978)	1003

Gamma GOF Test

A-D Test Statistic	0.335	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.81	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.116	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.162	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.515	k star (bias corrected MLE)	0.488
Theta hat (MLE)	1288	Theta star (bias corrected MLE)	1358
nu hat (MLE)	33.97	nu star (bias corrected)	32.22
MLE Mean (bias corrected)	662.8	MLE Sd (bias corrected)	948.7
		Approximate Chi Square Value (0.05)	20.24
Adjusted Level of Significance	0.0419	Adjusted Chi Square Value	19.75

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1055	95% Adjusted Gamma UCL (use when n<50)	1081

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.931	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.134	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.154	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.253	Mean of logged Data	5.268
Maximum of Logged Data	8.596	SD of logged Data	1.903

Assuming Lognormal Distribution

95% H-UCL	4115	90% Chebyshev (MVUE) UCL	2427
95% Chebyshev (MVUE) UCL	3057	97.5% Chebyshev (MVUE) UCL	3932
99% Chebyshev (MVUE) UCL	5650		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	976.1	95% Jackknife UCL	985.5
95% Standard Bootstrap UCL	980.8	95% Bootstrap-t UCL	1229
95% Hall's Bootstrap UCL	1330	95% Percentile Bootstrap UCL	1006
95% BCA Bootstrap UCL	1112		
90% Chebyshev(Mean, Sd) UCL	1234	95% Chebyshev(Mean, Sd) UCL	1493
97.5% Chebyshev(Mean, Sd) UCL	1852	99% Chebyshev(Mean, Sd) UCL	2558

Suggested UCL to Use

95% Adjusted Gamma UCL 1081

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations will not cover all Real World data sets. For additional insight the user may want to consult a statistician.

Chromium, Hexavalent

General Statistics

Total Number of Observations	33	Number of Distinct Observations	13
Number of Detects	11	Number of Non-Detects	22
Number of Distinct Detects	11	Number of Distinct Non-Detects	2
Minimum Detect	0.0019	Minimum Non-Detect	0.01
Maximum Detect	4.3	Maximum Non-Detect	0.05
Variance Detects	2.055	Percent Non-Detects	66.67%
Mean Detects	0.939	SD Detects	1.433
Median Detects	0.22	CV Detects	1.527
Skewness Detects	1.722	Kurtosis Detects	2.195
Mean of Logged Detects	-2.043	SD of Logged Detects	2.736

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.721	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.304	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.267	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.314	Standard Error of Mean	0.165
SD	0.904	95% KM (BCA) UCL	0.619
95% KM (t) UCL	0.594	95% KM (Percentile Bootstrap) UCL	0.597
95% KM (z) UCL	0.586	95% KM Bootstrap t UCL	1.061
90% KM Chebyshev UCL	0.81	95% KM Chebyshev UCL	1.034
97.5% KM Chebyshev UCL	1.345	99% KM Chebyshev UCL	1.957

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.27	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.812	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.274	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.341	k star (bias corrected MLE)	0.309
Theta hat (MLE)	2.753	Theta star (bias corrected MLE)	3.042
nu hat (MLE)	7.503	nu star (bias corrected)	6.79
MLE Mean (bias corrected)	0.939	MLE Sd (bias corrected)	1.69

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.121	nu hat (KM)	7.984
Approximate Chi Square Value (7.98, α)	2.726	Adjusted Chi Square Value (7.98, β)	2.57
95% Gamma Approximate KM-UCL (use when n>=50)	0.921	95% Gamma Adjusted KM-UCL (use when n<50)	0.977

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs. GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs. For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0019	Mean	0.32
Maximum	4.3	Median	0.01
SD	0.916	CV	2.867
k hat (MLE)	0.269	k star (bias corrected MLE)	0.265
Theta hat (MLE)	1.188	Theta star (bias corrected MLE)	1.208
nu hat (MLE)	17.75	nu star (bias corrected)	17.47
MLE Mean (bias corrected)	0.32	MLE Sd (bias corrected)	0.621
		Adjusted Level of Significance (β)	0.0419
Approximate Chi Square Value (17.47, α)	9.007	Adjusted Chi Square Value (17.47, β)	8.694
95% Gamma Approximate UCL (use when n>=50)	0.62	95% Gamma Adjusted UCL (use when n<50)	0.642

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.154	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.267	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.317	Mean in Log Scale	-5.11
SD in Original Scale	0.917	SD in Log Scale	3.226
95% t UCL (assumes normality of ROS data)	0.587	95% Percentile Bootstrap UCL	0.598
95% BCA Bootstrap UCL	0.732	95% Bootstrap t UCL	1.058
95% H-UCL (Log ROS)	30.36		

Chromium, Hexavalent - continued

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-4.771	95% H-UCL (KM -Log)	1.247
KM SD (logged)	2.454	95% Critical H Value (KM-Log)	4.565
KM Standard Error of Mean (logged)	0.453		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.317	Mean in Log Scale	-4.165
SD in Original Scale	0.917	SD in Log Scale	2.176
95% t UCL (Assumes normality)	0.587	95% H-Stat UCL	0.811

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.594	95% GROS Adjusted Gamma UCL	0.642
95% Adjusted Gamma KM-UCL	0.977		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.